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The role of herbaceous woodland perennial diversity for improving nutrient uptake of riparian areas

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Abstract
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Disciplines
Agronomy and Crop Sciences | Botany | Natural Resources and Conservation | Soil Science | Water Resource Management

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The role of herbaceous woodland perennial diversity for improving nutrient uptake of riparian areas – Phase II

Abstract:
Investigation of disturbed and intact woodlands herbaceous understories provided information on species present, biomass production and nutrient capture in preserved and secondary forests.

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$17,910 for year one
$15,910 for year two

Q What characteristics of woodland understory plant communities are functionally important in agricultural landscapes?

ECOLOGY

A The number, frequency, and abundance of different understory herbaceous species, especially spring-growing species, are greater in preserved forests than in secondary or disturbed forests, and are important for maintaining biodiversity and contributing to nutrient capture. Certain spring-growing species produce large amounts of biomass and substantially increase nutrient capture in the understory. Including these species in riparian woodland restoration should lead to increased effectiveness for nutrient capture.

Background

Natural riparian forests and reconstructed forested riparian buffers are well-positioned to intercept nutrients and sediment generated in predominantly agricultural landscapes throughout the upper Midwest. These systems are under increasing pressure to perform these functions while agricultural cultivation intensifies to meet growing demands for biofuel feedstocks as well as more traditional demands for row-crop production. However, nutrient uptake in natural and reconstructed riparian forests may be limited by characteristics of the herbaceous layer in these systems – many have reduced species richness and diversity, and reconstructed buffers generally do not have a shade-tolerant perennial herbaceous component.

This research extended an earlier pilot project funded by the Leopold Center to examine nutrient uptake by herbaceous vegetation in intact woodlands compared to disturbed woodlands in central Iowa. The earlier study demonstrated that intact woodlands had significantly greater herbaceous plant biomass and greater representation of spring-growing species, which also led to greater nutrient capture and storage in intact forests compared to disturbed (primarily grazed) forests.

For this project, the objectives were to expand on previous work by specifically examining secondary forests, and including a larger number of sites in order to:

- Identify specific perennial herbaceous species that are missing from secondary forests;
- Determine nutrient uptake by herbaceous perennials in intact vs. secondary forest systems, at the plot level for harvested plant material, and develop estimates for the landscape level;
- Identify key functional species with potential for introduction in newly-constructed buffers and in degraded secondary riparian forest areas; and
- Test the establishment potential of different species and species mixes.

Researchers excavate a plot dominated by wild ginger.

Approach and methods

Investigators examined six sets of paired plots where intact woodlands were located close to secondary woodlands. Study areas for the project were located in Iowa's Story, Hardin, Guthrie, Jasper, Iowa and Johnson counties.

All species present on five 20-m by 20-m plots were identified and percent cover was estimated. Plants located in three 0.5-m by 0.5-m quadrants in three of the five plots per site were harvested (once in spring and once in mid-summer), dried, separated into above and below-ground plant parts, and weighed to determine biomass. Dried samples then were analyzed to determine percent total nitrogen, which was used with biomass data to estimate nutrient capture at the plot and landscape scales. A similar set of methods was used to examine biomass production and nutrient capture by a group of key spring-growing species. Researchers also created two herbaceous perennial seed mixes using locally collected seed for 24 species, and sowed them into plots located in constructed forest riparian buffers at four sites.

Results and discussion

Project results indicated that the understory herbaceous flora of intact and early-successional systems are floristically distinct, with greater numbers, frequency, and abundance of spring-growing species (critical to early-spring nutrient retention) and specialist species (important for maintenance of biodiversity) in intact forests. However, in this study there did not appear to be significant differences in biomass or nutrient content between intact and secondary woodland understories.

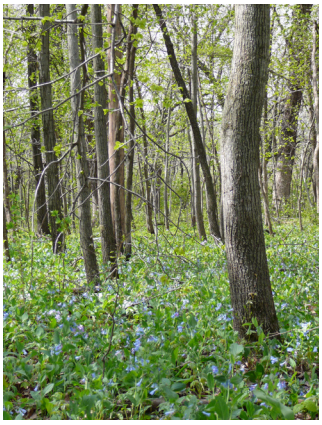
Although researchers expected to find more opportunities for increased function via restoration of secondary forests, it appears that even intact forest systems could be enhanced by addition of certain key species to enhance biomass production and nutrient capture in the understory. All four of the key species that were studied on single-species plots show great potential for use in understory restoration where biomass production and nutrient capture are important goals in a shaded system. These species included wild ginger (Asarum canadense), Virginia waterleaf (Hydrophyllum virginianum), Virginia bluebells (Mertensia virginica) and bristly buttercup (Ranunculus hispidus).

Conclusions

This study generated several important findings:

1. Perennial species missing in secondary forests. Forest understory herbaceous layer composition differs between intact forests and secondary forests. Based on cover, abundance and frequency of species in these two systems, intact forest flora include more spring-growing species and more specialist species.

2. Nutrient uptake by intact versus secondary forests. Researchers did not detect any statistically significant differences between biomass production or nutrient capture



Herbaceous understory cover in an intact forest dominated by Virginia bluebells.

for intact versus secondary forests. These results differed from a pilot study in which intact forests had significantly greater biomass production and nutrient storage capacity than did disturbed forests. Thus, although intact forests and secondary forests are floristically distinct, based on the sites chosen for this study those systems did not appear to be functionally distinct. The researchers expected that restoration of secondary sites could improve forest function, but based on this data, it appears that even forests classified as high quality or "preserved" forests could have nutrient retention enhanced by restoring key species.

3. Key functional species for reintroduction. The assessment of four important spring-growing species that produce very large quantities of biomass and that have relatively high tissue nitrogen levels indicates enormous potential for their use in restoration to improve nutrient capture in these systems.

4. Establishment potential for species/species mixes. Although previous studies documented success with a number of species included in the project's seed mix, the seeding study was not successful. Investigators believe the seed failure was due to flooding over the sites shortly after seed was sown. Additional research to determine the potential for success with establishment of these species via seeding into similar sites would be valuable.

Impact of results

Information generated by this study extends the results of earlier work supported by the Leopold Center. First, findings related to the distinctive nature of flora in systems that are intact versus those that are early-successional, including important differences for spring-growing herbaceous species, extend earlier findings of differences between relatively intact systems and those disturbed by grazing. Second, in this study, which included a wider range of preserved sites, investigators learned that even relatively "preserved" forests may benefit from some restoration of important perennial herbaceous species to improve their function. Finally, the suite of spring-growing species that were studied to assess their biomass production and nutrient content show great promise for reintroduction via restoration efforts to enhance forest function in terms of nutrient capture.

Education and outreach

Two articles on the project findings are in preparation, one for the journal *Ecological Restoration* and a second for the journal *Forest Ecology and Management*.

The project was featured in an interactive workshop conducted by Thompson at the 2008 Iowa State Shade Tree Short Course. Project results are being shared as part of field days and workshops through Forestry Extension in 2009 and beyond. Investigators will present findings to district foresters with the Iowa Department of Natural Resources and individual forest landowners. ISU students learned of project results in a course on identification of woodland herbaceous perennial plants to be offered in spring 2009.

Leveraged funds

The investigators used Leopold Center funding to leverage $10,000 in additional project support from the Pioneer Foundation as well as partial funding for a graduate research assistant from forestry-dedicated McIntire-Stennis funds allocated to ISU NREM.

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